Interference and Measurements

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Interference

IIHF rules: 2 min penalty

Classification of Interference

- Electromagnetically coupled
  - Insufficient shielding
  - Bad connections
  - Insufficient filtering
- Capacitively and inductively coupled
  - Bad cabling
  - Lines too close to each other
- Galvanic coupled
  - Potential difference between zero points
- Other interference

Electromagnetic Interference

- The most important type of interference in radio technology
- Harmonic multiples of the fundamental frequency are the most important of spurious emissions, and they always exist
- Unwanted intermodulation products and spurious oscillations cause great trouble if they get in the antenna
- If the transmitter is not shielded properly, high-frequency power easily gets where it is not supposed to
- Cabling, meters, and vent holes are troublesome and need to be shielded
- EM interference may be caused by out-of-tune antennas, missing balun, or otherwise high SWR
- All amateur radio transmitters are to be constructed in metallic boxes, and this is also recommended for receivers
- The RF power must not get into the power network (50 Hz)
- Grounding is crucially important

Capacitive and Inductive Interference

- Appear together, but are not so important in radio technology (in amateur T2 exam)
- Make measurements more difficult
- Interfere with digital and audio frequency lines

Galvanic Interference

- Most commonly appears as 50 Hz humming, caused by insufficient grounding
- Potential difference between equipment may exist if there are several grounding points

Other Interference

- Key clicks in CW, caused by too short rise and fall times that widen the signal bandwidth
- Overmodulation and overdeviation (or impurity of signal) can make the transmission unreadable both on SSB and FM

Elimination of Electromagnetic Interference

- Filters solve the problems with harmonic spurious emissions, just choose the proper type depending on the situation
- Fix your connectors, cabling, shielding, and grounding
- Put ferrite chokes in digital and AF lines
- Mains filter or ferrite choke is needed in the power cable
- Spurious oscillation can be prevented using chokes

Elimination of Capacitive and Inductive Interference

- Grow the space between connectors
- Use shielded cables (coax) or twisted pairs

Elimination of Galvanic Interference

- All grounding wires must go to one point, at a proper grounding rail
- Grounding wires must be as short as possible
- 2.5 mm², or better 4–8 mm² wire should be used in grounding between equipment

Elimination of Other Interference

- Key clicks are damped with a keying filter in the transmitter
- Microphone gain is adjusted individually for every mic, and preferably a bit too low to avoid overmodulation
- It is advisable to ask other stations about your signal quality
- Speech processor is not needed in normal operation

In Case of Interference

- Radio amateur is always obliged to troubleshoot the interference possibly caused by him, and to prevent it
- Primarily, the radio amateur must install filters to his own transmitter, not in the receiver that is interfered
- The real cause of the interference is not nearly always the radio amateur. Be a little careful about the accusations.
- Reducing transmit power is usually the easiest and cheapest way to prevent interference e.g. in your neighbour's tv
- In most difficult situations it is possible to contact the SRAL interference advisor

Questions on Interference

A) Your 70 cm transmitter blocks the receiver of a GSM base station. To prevent this, you should among other things

1. Install a low-pass filter to your transmitter
2. Install a high-pass filter to your transmitter
3. Install a bandstop filter for the GSM frequency to your transmitter
4. Push the GSM operator to install the needed filters to their receiver

B) Your neighbour's tv shows interference, which you suppose to be caused by HF signals.

1. **Because you don't want to take responsibility, you say that the interference is caused by a nearby CB transmitter**
2. Ask your radio amateur friend for help, and with the neighbour examine whether the interference is caused by your HF transmitter
3. Tell that your transmitter cannot cause interference and show a law text reading "amateur radio station must not be used to cause interference"
4. Quit the amateur radio hobby and sell your equipment
5. Suspect that there is a 27-MHz high frequency heater in the neighbourhood

Answers

A) Your 70 cm transmitter blocks the receiver of a GSM base station. To prevent this, you should among other things

1. Install a low-pass filter to your transmitter CORRECT
2. Install a high-pass filter to your transmitter WRONG
3. Install a bandstop filter for the GSM frequency to your transmitter CORRECT
4. Push the GSM operator to install the needed filters to their receiver WRONG

B) Your neighbour's tv shows interference, which you suppose to be caused by HF signals.

1. **Because you don't want to take responsibility, you say that the interference is caused by a nearby CB transmitter WRONG**
2. Ask your radio amateur friend for help, and with the neighbour examine whether the interference is caused by your HF transmitter CORRECT
3. Tell that your transmitter cannot cause interference and show a law text reading "amateur radio station must not be used to cause interference" WRONG
4. Quit the amateur radio hobby and sell your equipment WRONG...
5. Suspect that there is a 27-MHz high frequency heater in the neighbourhood CORRECT

Measurements

Measurement equipment

- Voltage meter }
- Current meter } multimeter
- Resistance meter }
- oscilloscope
- Frequency counter
- Spectrum analyser
- Power meter
- SWR meter…

Multimeter

- Multimeter is a combined voltage, current, and resistance meter, and sometimes more
- There might be a frequency, conductivity, transistor, diode, and temperature meter
- Either analog or digital, the latter are cheaper, more precise, and more common
- Remember that a mere voltage meter allows you to measure current and resistance (using shunt resistance and current division)

Oscilloscope

- Analog models only show the signal shape as a function of time
- Voltage and frequency can be read with the help of the grid
- Oscilloscopes suit for measuring and detection of periodic signals
- Digital oscilloscopes may calculate everything themselves
- Oscilloscopes have a limited bandwidth, commonly e.g. 20 MHz

Frequency counter and spectrum analysator

- Frequency counter is based on divider, counter, and a reference oscillator
- Frequency counters are used to precisely determine the signal frequency
- Frecuency counters need to be calibrated
- The reference oscillator (OCXO, TCXO) determines the quality of the counter
- Spectrum analyser shows the signal power as a function of frequency, used in e.g. measuring spurious emissions

Power and SWR meter

- Power meter is usually used to measure transmitted power
- There are several ways to measure power
- SWR meter measures the standing wave ratio (impedance matching) between the transmitter and the antenna cable
- SWR cannot be smaller than one

Measuring Transmitted Power Using an Oscilloscope

- In the measurement you need: a 50-ohm dummy load that can absorb all the transmitted power, an oscilloscope, and enough attenuation in the probes
- Vpp (=voltage peak to peak) gives the power
  $P = (Vpp / 2\sqrt{2})^2 / R = Vpp^2 / 8R$
- The method is exact but may be interfered with forward and reflected power on the line, that is, standing waves

Measuring Transmitted Power Using a Multimeter

- Transmitted power may be measured fairly exactly using a multimeter, with the same principle as with the oscilloscope but with a different connection
- The method is suitable for low frequencies and high powers
- The threshold voltage of the diode must be taken into account

Effective Radiated Power, ERP

- The transmit power is 100 watts, cable losses are 1.5 dB, and the antenna gain 7.5 dBd. What is the effective radiated power?
- 10•lg100 = 20 dBW
- 20 – 1,5 + 7,5 = 26 (dBW)
- 10^(26 / 10) = 398.107… W ~ 400W ERP
- 7.5 dBd = 9.6 dBi, thus the EIRP is 2.14 dB higher than ERP

Questions on Measurements

A) You measure your transmitter power using a 50-ohm dummy load and an oscilloscope with enough bandwidth. The result is Vpp = 100 V. The transmitter power is

1. 10 W
2. 25 W
3. 100 W
4. 200 W

B) **You wish to determine the power levels of the harmonic emissions of your transmitter. You need**

1. A spectrum analyser part to be attached into an oscilloscope
2. A precision voltage meter that gives the voltage level in decibels
3. An ampere meter to determine the input power of the transmitter
4. A dummy load that can take the whole power of the transmitter

Answers

A) You measure your transmitter power using a 50-ohm dummy load and an oscilloscope with enough bandwidth. The result is Vpp = 100 V. The transmitter power is

1. 10 W WRONG
2. 25 W CORRECT
3. 100 W WRONG
4. 200 W WRONG

B) **You wish to determine the power levels of the harmonic emissions of your transmitter. You need**

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2. A precision voltage meter that gives the voltage level in decibels WRONG
3. An ampere meter to determine the input power of the transmitter WRONG
4. A dummy load that can take the whole power of the transmitter CORRECT

Questions?

- Here be questions